Technical Report

AD 640 127

MECHANIZATION STUDY OF THE THERMOPHYSICAL PROPERTIES RESEARCH CENTER, PURDUE UNIVERSITY

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ABSTRACT

The data files at the Thermophysical Properties Research Center (TPRC) are stored on magnetic tape and are used for mechanized retrospective searches and to produce the original copy for the Center's "Retrieval Guide to Thermophysical Properties Research Literature" publication. In the near future, the Center will be connected directly to Purdue's computer center via a UHF radio circuit. Partly because of the relatively frequent changes in computer equipment, the Center has limited its use of mechanized processes. The Director believes that at present his staff can perform most searches faster by manual reference than by machine.

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I. SUMMARY

The data files of the Thermophysical Properties Research Center (TPRC) has been entered on magnetic tape. These files are used for mechanized retrospective searches and to produce the original copy for the Center's "Retrieval Guide to Thermophysical Properties Research Literature" publication. The Retrieval Guide is the ordered reproduction of all information contained in TPRC's files in book form and is available to purchasers who desire a convenient tool for manual retrospective searches of literature current with the latest volume of the Guide. The mechanized search process is primarily used by the Center for covering the literature in the data base that is current since the latest publication.

The Thermophysical Properties Research Center was established in 1957 under the sponsorship of both government and industrial organizations to advance the knowledge of the thermal properties of matter. It is a separate unit within Purdue University's schools of engineering. (Appendix A illustrates the organizational structure of the the Center.) The center consists primarily of an interdesciplinary staff of chemists, physicists, chemical engineers, and mechanical engineers. This staff operates in four major areas of activity related to thermophysical properties:

1. Scientific Documentation

2. Critical Tables of Properties

3. Experimental Research

4. Theoretical Research

The Center's data base consists of information on the thermophysical properties of about 42,900 substances. The properties are divided into seven groups for a total of 13 properties, such as thermal conductivity, specific heat, thermal diffusivity, etc., which represent the data base at the present time.

At present, the Center is searching four abstracting journals: Technical Abstract Bulletin, Scientific and Technical Aerospace Reports, Chemical Abstracts, and Metallurgical Abstracts. It also subscribes to about 98 scientific and technical journals, which are scanned by Center personnel. Information is also obtained by reviewing miscellaneous technical reports, dissertations, compendia, informal sources, etc.

The Center provides information to its sponsors and their contractors, and, on a selective basis, to members of the scientific community.

II. MECHANIZATION

1. CHRONOLOGY

In 1957 when the Center was founded, consideration of mechanized techniques to aid the Center's operations began. The logical flow of the Center's developing documentation operations was designed to be easily adaptable to computer processing.

In 1959, the first program for information storage and retrospective searching was developed. Accession numbers were the only output, and corresponding bibliographic printout was accomplished by selecting and printing the necessary EAM punched cards. This program was designed for a Datatron computer.

During 1960 and 1961, the program was rewritten for a Univac computer which replaced the Datatron.

In 1963, the program was rewritten for the IBM 7090 computer. In 1964, the program was again rewritten, this time for the IBM 7094 computer. In 1966, the program will again be rewritten for the IBM 360 which may replace the IBM 7094.

2. DESCRIPTION OF PROCESSES

Figure 1 illustrates the documentation system flow that is summarized in the following paragraphs:

(1) Input Procedures

1. Abstracting journals are searched, and pertinent references in selected sections are marked on an Abstract Search Record Card in the columns representing the properties and physical state being reported. One card per abstracting journal is used.

2. Clerical assistants relocate the selected journal, cut out the referenced abstracts, and insert these abstracts into a 3 by 5 acetate folder. Abstracts that cannot be clipped are photographically reproduced. When the abstracts are clipped, they are labeled with the journal identification.

3. The actual document is procured in hard copy and microfiche form.

4. Coders then assign code numbers to the abstract to describe a total of 14 items of technical and bibliographic nature. These codes are entered in the Reference Coding Form as shown in Figure 2.

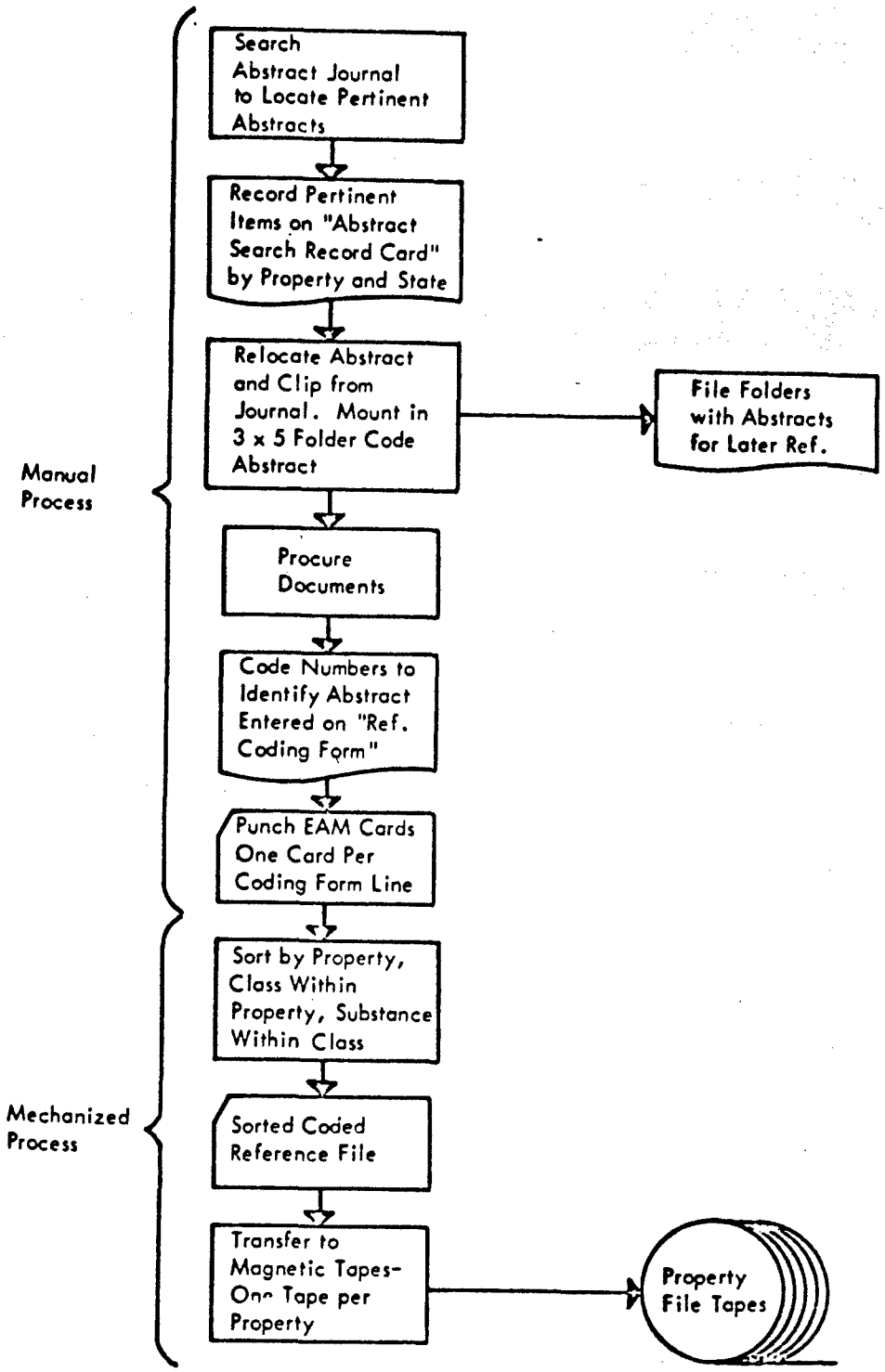

FIGURE 1
Flow

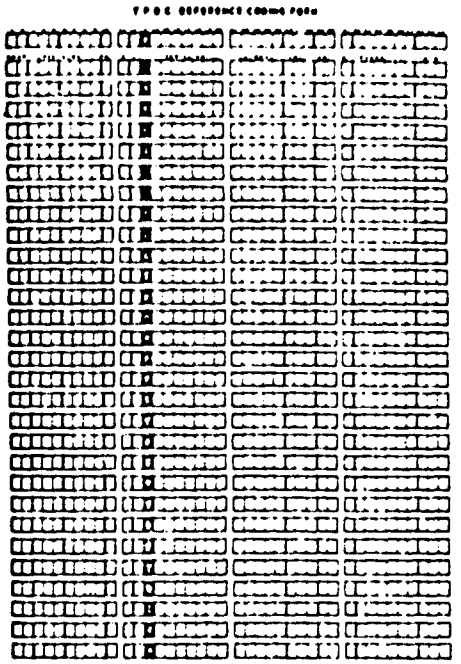

FIGURE 2
TPRC Reference Coding Form

The codes are as follows:

(1)	Properties	- 2 digits for up to 99 properties
(2)	Substance Class	- 3 digits for up to 999 classes
(3)	Substance Name	- 4 digits for up to 9, 999 substances in a class
(4)	Physical State	- 1 digit for up to 9 states
(5)	Type of Subject Coverage	- 1 digit to indicate nature of coverage such as theoretical, experimental, etc.
(6)	Language of Original Article	- 1 digit for up to 9 languages
(7)	Temperature Range	- 1 digit
(8)	Serial Number of the Reference	- 7 digits for up to 10 million bibliographic references
(9)	Journal Name	- 5 digits for up to 100, 000 journal codes

(10) Journal Volume	-	3 digits
(11) Journal Number	-	2 digits to indicate the serial number within a volume
(12) Journal Series	-	1 digit
(13) Beginning Page Number	-	6-digits to indicate the starting page of the article
(14) Journal Year	-	3 digits which omit the thousands' position in the year group

Items (2) and (3) above represent the basis of information organization in the Center. Item (2), which the substance class, has three digits which are assigned by series units as follows:

Series 000	Work not involving substance class

Example: 011-Surveys; 031-Theory; 061-Patents

Series 100 and 200	Substance described by chemical formula
Series 300	Ferrous metal alloys (alloys where the amount of iron exceeds 49 percent or is greater than any other single constituent).
Series 400	Nonferrous metal alloys
Series 500 and 600	Substances that cannot be described correctly in a single chemical formula and are not metal alloys.

Example: 551-structures of intermetallic and ceramic compounds; 621-fabrics and yarns

One or more lines on the Reference Coding Form are required to code each abstract depending upon whether one or more properties, substances, or physical states are discussed. A typical abstract requires four lines.

5. The information on one line of the Reference Coding Form is then punched in sequence in the first 40 columns of an EAM card. The punched cards are sorted on the first nine columns by property, class within property, and substance within class.

6. The sorted cards are used to update the master magnetic tape file once each year, after which they are discarded. Before the taping, the accumulated cards are used for searching. In the near future, it is planned to update the tapes monthly.

(2) Output

If a retrospective search query is handled by machine, the query is refined and entered on an EAM punched card called a query card. The query must specify the name of the material and the property of interest. Additional information may include the physical state of the material, the subject coverage, language of the original article, temperature range, and year of publication.

Query cards are then run on the computer with the appropriate property file tape. In response to the retrospective search run, the computer punches an EAM card for each located item,

giving the item a serial number and bibliographic code of zero. The resulting printout is all of the information on the magnetic tape file pertaining to a specific substance.

At present, the draft of the Retrieval Guide (Books 2 and 3 of the three-book volume) is prepared by requesting an entire printout of all of the property files. This is done in the form of an unrestricted query. An example of a search output is given in Appendix B.

3. ACTIVITIES BEING PLANNED OR DEVELOPED FOR MECHANIZATION

When the system is reprogrammed for the IBM 360, the Center will be connected directly to Purdue's computer center via a UHF radio circuit. The Center has already acquired a teletype and paper punch unit and is conducting, on a time-sharing basis, computational and retrieval experiments with the National Bureau of Standards and others.

III. PROGRAM SYSTEM DATA

1. MAJOR FILES

The TPRC data files are stored on magnetic tape, one tape per property. On each tape, the data are in packed form and are ordered by substance classification (digits 3-5) and substance number within the classification (digits 6-9). Currently, the initial blocks of each tape contain the directory for the tape. A block consists of 20 words of 10 digits (and a sign position) each. Each tape has a capacity of 20,000 blocks or 400,000 words. Each data entry consists of five words--four words for the data and one for error control. There may be changes made in this configuration in the near future.

The entry represents 14 items of coded information which are read into the computer from an EAM punched card. The following is the format of the data entry:

Data Word	Digit Positions	Information Coded
1	1, 2	Property
1	3, 4, 5	Classification
1	6, 7, 8, 9	Substance

Data Word	Digit Postions	Information Coded
1	10	Physical State
2	1	Subject Coverage Type
2	2	Language
2	3	Temperature Range
2	4, 5, 6, 7, 8, 9, 10	Serial No.
3	1, 2, 3, 4, 5	Journal
3	6, 7, 8	Volume
3	9, 10	Number
4	1	Series
4	2, 3, 4, 5, 6, 7	Starting Page of Article
4	8, 9, 10	Year

2. PROGRAMS

(1) File Preparation

Appendix C-1 illustrates the system flow for the initial file preparation. The data input is on EAM punched cards prepared as described in Section II and sorted on the first nine columns. Cards with identical digits in columns 1 through 5 are read into the main memory as a group. Then, one entry at a time, they are read onto the tape file along with a new directory item at the head of the tape. Error checking is accomplished after the reading onto tape of each entry.

When the last card is read from the subset with identical digits in columns 3 through 5 (all the same substance classification code), the next group of cards is read into the main memory and the process iterated. When the last card is read from the set with identical digits in columns 1 and 2 (same property code), the program is stopped and the tape changed. The iterative process is then continued until all of the data cards have been read onto the respective tapes.

(2) File Maintenance

The program system flow for the file maintenance run is shown in Appendix C-2. Punched cards containing new additions for the data base are sorted on columns 1 through 9 and then separated on the basis of identical property codes in columns 1 and 2. Cards for one property are then read into the main memory.

The first group of entries having identical codes in positions 1 through 9 (same property, substance classification, and substance code) are compared to the old properties' directory to determine the proper tape address block for storage. Data from the old property tape are transferred to the update tape until the last old item in the determined storage address block is detected. The old tape servo is then stopped and the first new item for storage

is compared on data words 3 and 4 to all the items in the last address block just entered on the update tape. This comparision is a check for preexisting duplicate entries. (A duplicate can exist only if the first data word of two entries is identical. Since this word is already determined by the storage address block, it is only necessary to compare on data words 3 and 4.) If a new entry is not a duplicate of an existing one, it is stored on the update tape at the next available position in the address block. The update tape is then reversed to its head and the tape directory block modified to incorporate the new entry. Duplicate items are rejected after recording on a punched card. This process is iterated until the last item of the first group with common data words #1 is detected. The next group with the common feature is then moved up for storage.

When the last item of the last group has been processed, the run is ended for the selected property. It is then necessary to stack the next set of common property cards, to replace the update with a clean tape (or the old property tape just updated), and to mount the corresponding old property tape next to be updated. Note that data on the tapes are maintained in a packed arrangement with no gaps for updating as a result of the technique of interfiling on a new tape from both the old tape and the main memory.

(3) Information Retrieval

Search cards in the same format as the data cards are prepared, specifying the parameters for which bibliographic data are desired. These are read into the computer as illustrated in Appendix C-3 and compared to item referring to the same substance (same data word #1) from the appropriate property file tape. When a match is made, the item data from the tape is punched out on an EAM answer card. The process is iterated until all query cards are processed for one property. Additional properties may be run after correspondingly changing the property file tape. When all of the queries are processed, the answer card stack is run in a tabular form which lists the bibliographic data in the appropriate line format.

IV. EQUIPMENT, COSTS, AND EVALUATIONS

1. EQUIPMENT

The program as described above was designed for the computational equipment listed as follows:

Datatron (Electrodata) Electronic Computer with 4,000 ten-digit words of magnetic drum storage, 2 magnetic tape drives, 400,000 (20,000 blocks) words of storage per tape.

IBM 026 card punch

IBM 056 verifier

IBM 083 sorter

IBM 514 reproducer

IBM 407 tabulator

The Datatron was replaced by a UNIVAC, then an IBM 7090, and later, by an IBM 7094. Plans call for the 7094 to be replaced by an IBM 360.

2. COSTS

TPRC Staff Programmer	half-time
Computer rental per hour	$80
Total annual computer center cost	$10,000
Average computer time to print data section of the Retrieval Guide	5 or 6 hours at $40 per hour

The cost in computer time to complete a bibliographic search is less than a minute to search and 40 minutes to print out a search of 50 pages, at an approximate print-out speed of 800 wpm.

3. FACILITY'S EVALUATION OF SYSTEM

Because of t . relatively frequent changes in computer equipment, the Center has limited its program development. In addition, most retrieval queries can be answered by manual reference to the Retrieval Guide or by consulting with one of the staff members.

Cost data resulting from computer usage is not very meaningful because of the relatively greater amount of effort involved in manual preparation of a query than is spent in the mechanized process.

The Center has found it very useful to provide its own programmer. This arrangement permits the programmer to remain conversant with the TPRC technology.

The Director believes that, at present, he can perform a search faster manually than by machine. This is with reference to the total "Real Time," which includes all the time consumed between the asking of the question and the receipt of the information by the requester.

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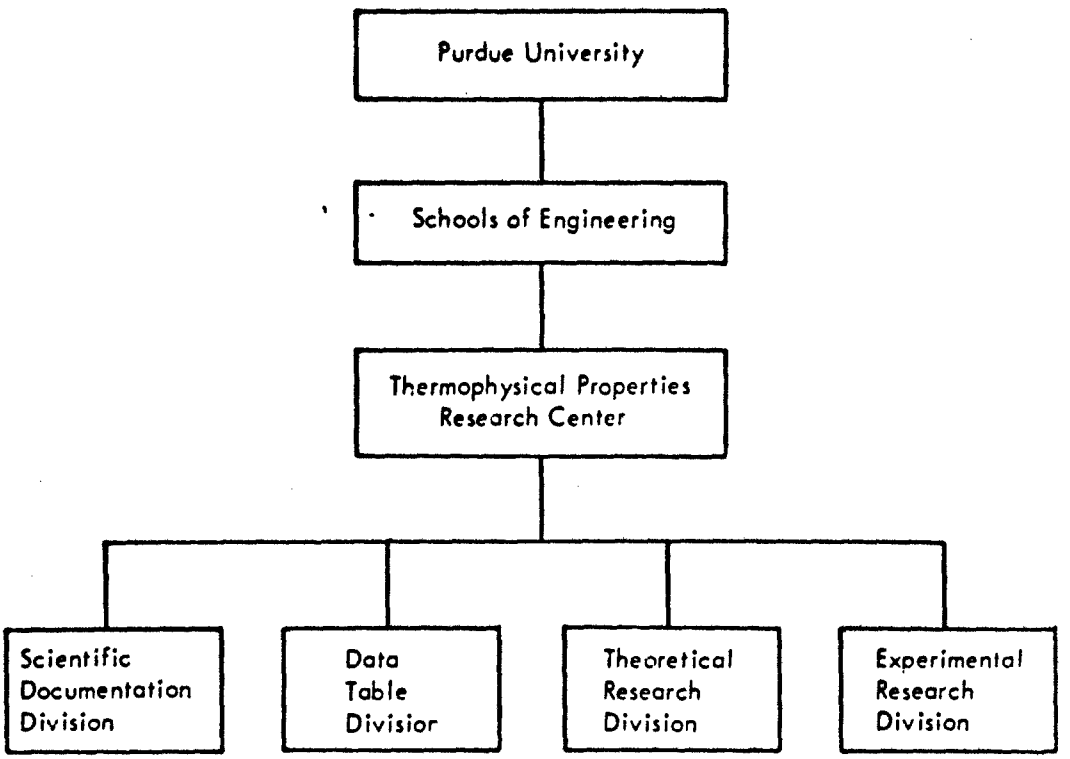
"Substance Classificatiation Developed for Mechanized Literature Search by the Thermophysical Properties Research Center," by T. Wing, and Y. S. Touloukian, TPRC Report No. 3, April 1958, TPRC, Purdue University, Lafayette, Indiana.

APPENDIX A

ORGANIZATION CHART



Organization Chart

APPENDIX B

SEARCH OUTPUT

BIBLIOGRAPHIC SEARCH ON THERMAL CONDUCTIVITY, SPECIFIC HEAT, PACI
AND THERMAL DIFFUSIVITY OF 14 SPECIFIED METALS AND ALLOYS
CONDUCTED FOR ARTHUR D. LITTLE, INC. BY THE
THERMOPHYSICAL PROPERTIES RESEARCH CENTER IN JANUARY, 1966.

INFLUENCE OF THE VARIATION WITH TEMPERATURE OF THE
THERMAL CONDUCTIVITY COEFFICIENT ON THE PROPAGATION
OF HEAT IN A PERIODIC SYSTEM.
SICARD L EYRAUD L ELSTON J EYRAUD CI
J PHYS RADIUM
21 656-8 1960 CA 55 5071 20536

THERMODYNAMIC PROPERTIES OF THORIUM DIOXIDE FROM 298
TO 1200 K.
VICTOR ANDREW C DOUGLAS THOMAS B
J RESEARCH NATL BUR STANDARDS
65 A 2 105-11 1961 JA 44 200 20571

CHARACTERISTICS GOVERNING THE FRICTION AND WEAR
BEHAVIOR OF REFRACTORY MATERIALS FOR HIGH TEMPERATURE
SEALS AND BEARINGS.
SIBLEY LEWIS B MACE ARTHUR E CRIESER DANIEL R
ALLEN C MALCOLM BMI USAF
ASTIA AND CTS
WADC TR 60-54 AD 243857
PB 171010 1-47 1960 20600

PROPERTIES OF SOME METALS AND ALLOYS
INTERNATIONAL NICKEL CO. INC. NEW YORK, N. Y.
INTERNATIONAL NICKEL CO. INC.
1-30 20610

BERYLLIUM AS A STRUCTURAL MATERIAL.
MARTIN A J
MACHINE DESIGN
32 252-4 1960 RM 17 259-P 20620

A HEAT-CAPACITY FUNCTION WITH VELOCITY DISPERSION FOR
ISOTROPIC SOLIDS.
BAKER S A MARTIN P
J PHYS CHEM SOLIDS
9 3-4 198-213 1959 SA 62 8818 20784

THERMAL PROPERTIES OF GRAPHITE, MOLYBDENUM, AND
TANTALUM TO THEIR DESTRUCTION TEMPERATURES.
BAKER A S MCCLELLAND J D
PHYS AND CHEM SOLIDS
15 17-26 1960 CA 55 11055 20796

THERMAL PROPERTIES OF REFRACTORY MATERIALS /SECOND
QUARTERLY PROGRESS REPORT./
CAPE J A ATOMICS INTERNATIONAL ARPA
ASTIA
AI-6127 AD 251317
1-12 1961 20843

APPENDIX C

FLOW CHARTS OF PROGRAMS

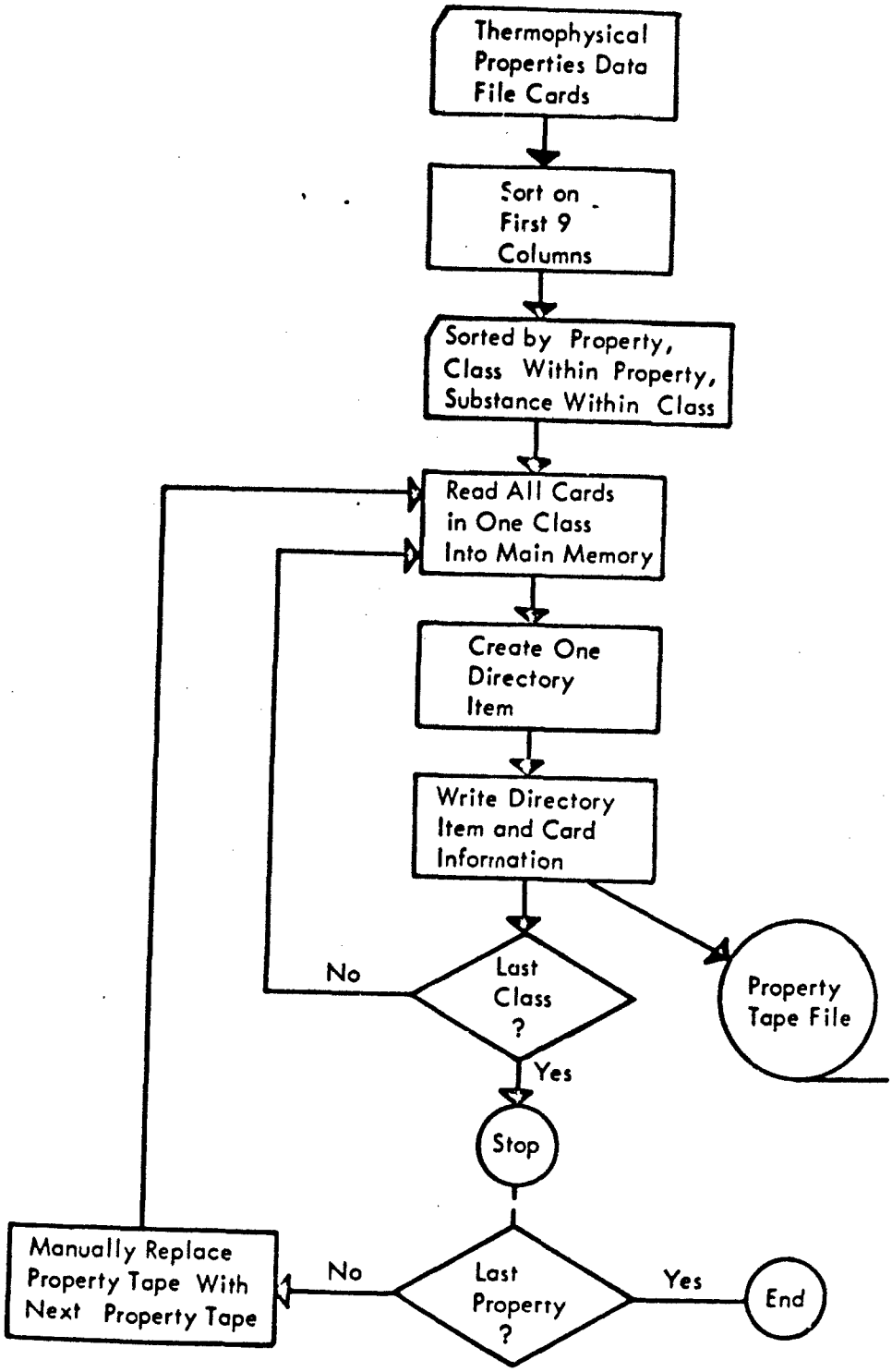


FIGURE C-1
Flow Charts of Programs

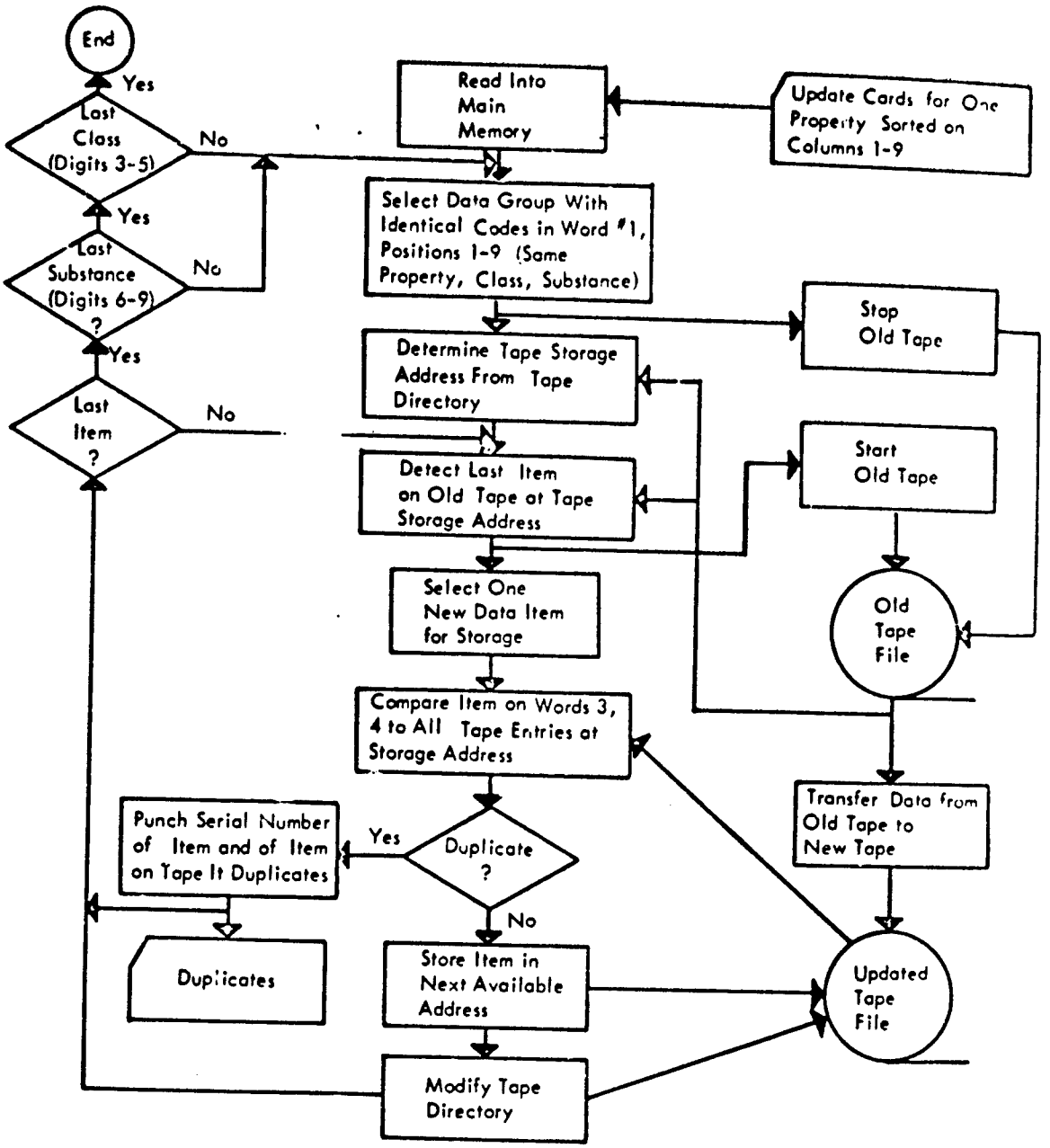


FIGURE C-2
File Maintenance

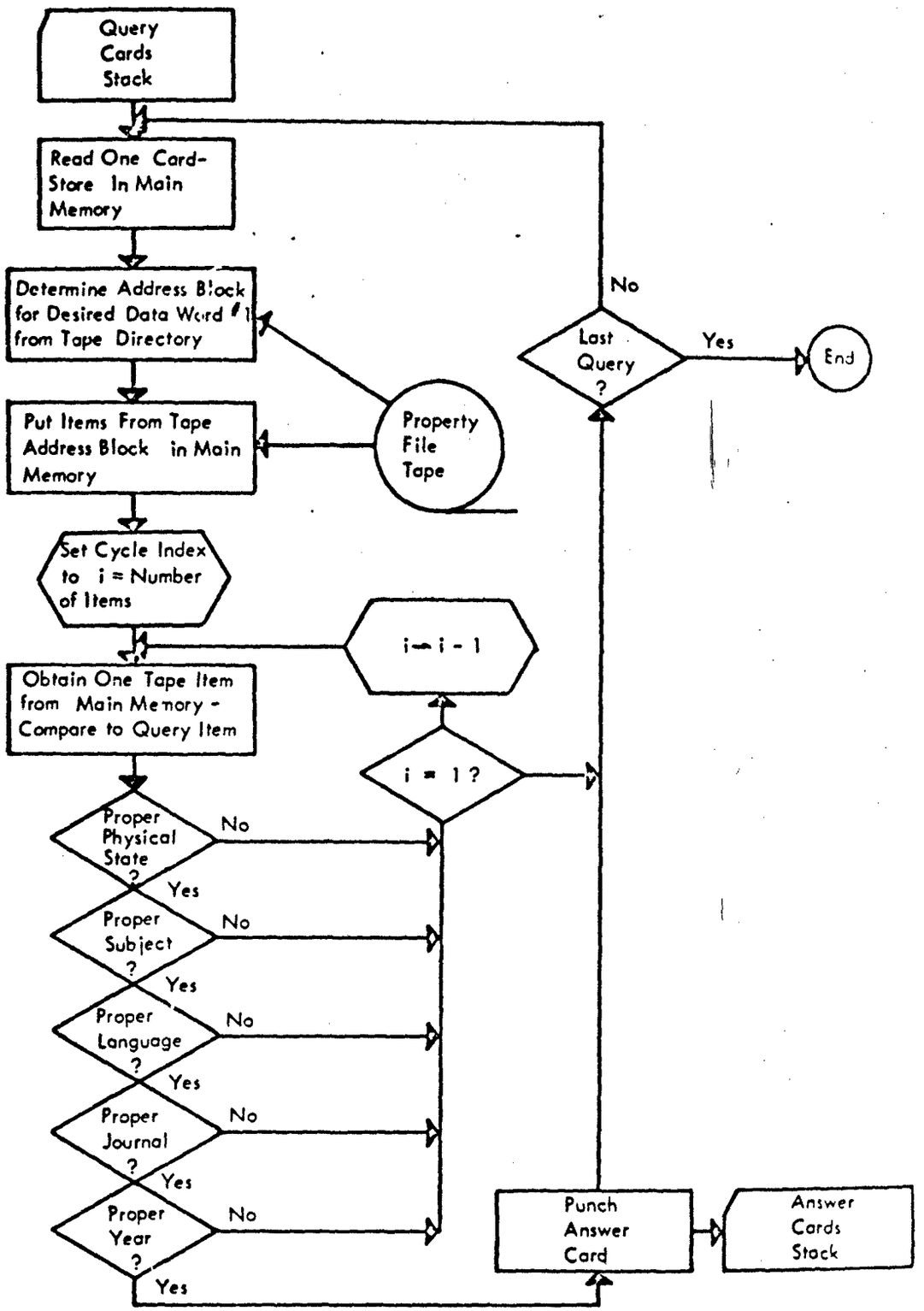


FIGURE C-3
Information Retrieval

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is)

1 ORIGINATING ACTIVITY (Corporate author) BOOZ ALLEN APPLIED RESEARCH, INC. 4733 Bethesda Avenue Bethesda, Maryland 20014	2a REPORT SECURITY CLASSIFICATION Unclassified 2b GROUP

3 REPORT TITLE

Mechanization Study of the Thermophysical Properties Research Center, Purdue University

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report of on-site survey

5 AUTHOR(S) (Last name, first name, initial)

G. A. Kershaw, D. Crowder, J. E. Davis, E. G. Loges, E. Merendini, S. M. Thomas

6 REPORT DATE	7a TOTAL NO. OF PAGES	7b NO. OF REFS
September, 1966	33	5

8a CONTRACT OR GRANT NO	9a ORIGINATOR'S REPORT NUMBER(S)
DSA-7-15489 b PROJECT NO	914-1-33
c d	9b OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AD 640 127

10 AVAILABILITY LIMITATION NOTICES

Distribution of this Document is unlimited

11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY
None	Defense Supply Agency Defense Documentation Center Cameron Station, Virginia

13 ABSTRACT

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DD FORM 1473

Unclassified

Security Classification

Security Classification

KEY WORDS	LINK A	LINK B	LINK C
	ROLE WT	ROLE WT	ROLE WT
Digital Computers Experimental Data Information Retrieval			

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